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Major Currents Off the West Coasts of North and South America.

NAVAL OCEANOGRAPHIC OFFICE NSTL STATION MS

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ERRATA

TR-221, "Major Currents off the West Coasts of North and South America"

page v, Contents; for El Nino read El Niño

page 7, Table 1, Region F, last line; for MME read NNE

page 14, Table 3, left column; for 40° to 50°N read 40° to 48°N

FOREWORD

This report is intended to help meet a need for the identification of the major currents off the west coasts of North and South America and a comprehensive summary of their principal characteristics. The information given herein is based on published reports and directly measured data, as well as considerable unpublished data, of which a large amount has recently been obtained. Much of these data has been analyzed specifically for this report.

This is the second of a planned series of three reports. The first includes descriptions of the currents of the North and South Atlantic Oceans.

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Captain, U. S. Navy
Commander
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CONTENTS

LIST OF FIGURES

LIST OF TABLES

MAJOR CURRENTS OFF THE WEST COASTS OF
NORTH AND SOUTH AMERICA

Introduction

The descriptions of eight principal currents in this report are based mainly on data obtained by direct methods in regions from the Bering Sea to Cape Horn. Except for the Peru and Cape Horn Currents, surface flows appear to be ill defined and exhibit characteristic variability.

The usual graphic presentation of ocean currents is, at best, a static picture. The surface of the ocean is in constant motion, the movement being exceedingly variable in some regions and relatively constant in others. The currents described in this report are those where the movement within specified boundaries exhibits a permanent or seasonal flow. The regions beyond the boundaries of the currents are those where flows, frequently considered part of the prevailing current, are less defined, described from insufficient data, mainly tidal, under the influence of winds or river discharge, or variable and turning. The boundaries indicate gradual change between zones of more persistent flow and zones of less stable or weaker flow.

The approximate boundaries and the main body of each current shown are based on ship drift observations and direct measurements by instrument, which describe the two main features of the current, namely, direction and speed. Dynamic topography presentations are mentioned or shown only where they might prove of interest by comparison with results of direct measurements.

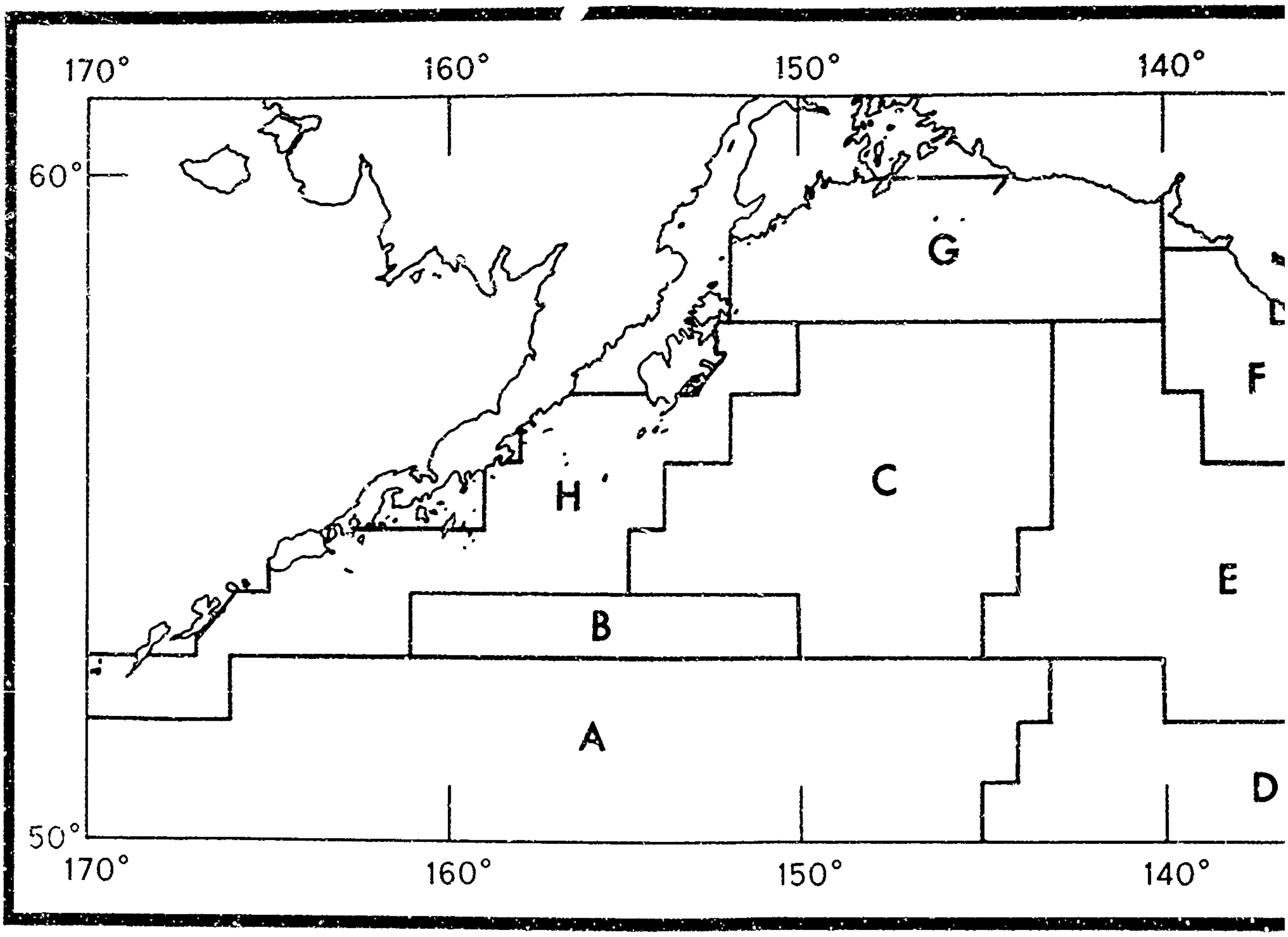
ALASKA CURRENT

Surface current data in the Gulf of Alaska are scarce and unevenly distributed; of almost 9,000 observations north of 50°N, about 6,700 are located in regions A, B, and D of Figure 1. Inasmuch as the southern boundary of the Gulf of Alaska is north of 55°N, regions A, B, and D may be considered outside the gulf, and the persistence of the eastward flow through these regions is due mainly to the influence of the Subarctic Current.

The Alaska Current actually originates from the part of the Subarctic Current that is diverted north in the vicinity of Queen Charlotte Islands, and is a slow, wide, counterclockwise flow along the coast to about 170°W. The current appears to be somewhat faster in regions G and H (Figure 1) than elsewhere.

Figure 1 and Table 1 indicate the general flows in the gulf; significant frequencies of flow in other directions also are shown in Figure 1. The shaded outlines show that the Alaska Current is weak, with little seasonal change in mean speeds, so that it is easily influenced by strong winds associated with frequent storms through the gulf, particularly from September through May.

The data in Figure 1 and Table 1 are based on surface ship drift observations and show a very close directional relationship with the computed surface flow and with the schematic shown in Figure 2.



LEGEND

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EACH DIVISION ON A DIRECTION ARM INDICATES 2 PERCENT FREQUENCY AND 0.1 KNOT.

THE ARROW SHOWS PREVAILING DIRECTION AND MEAN SPEED

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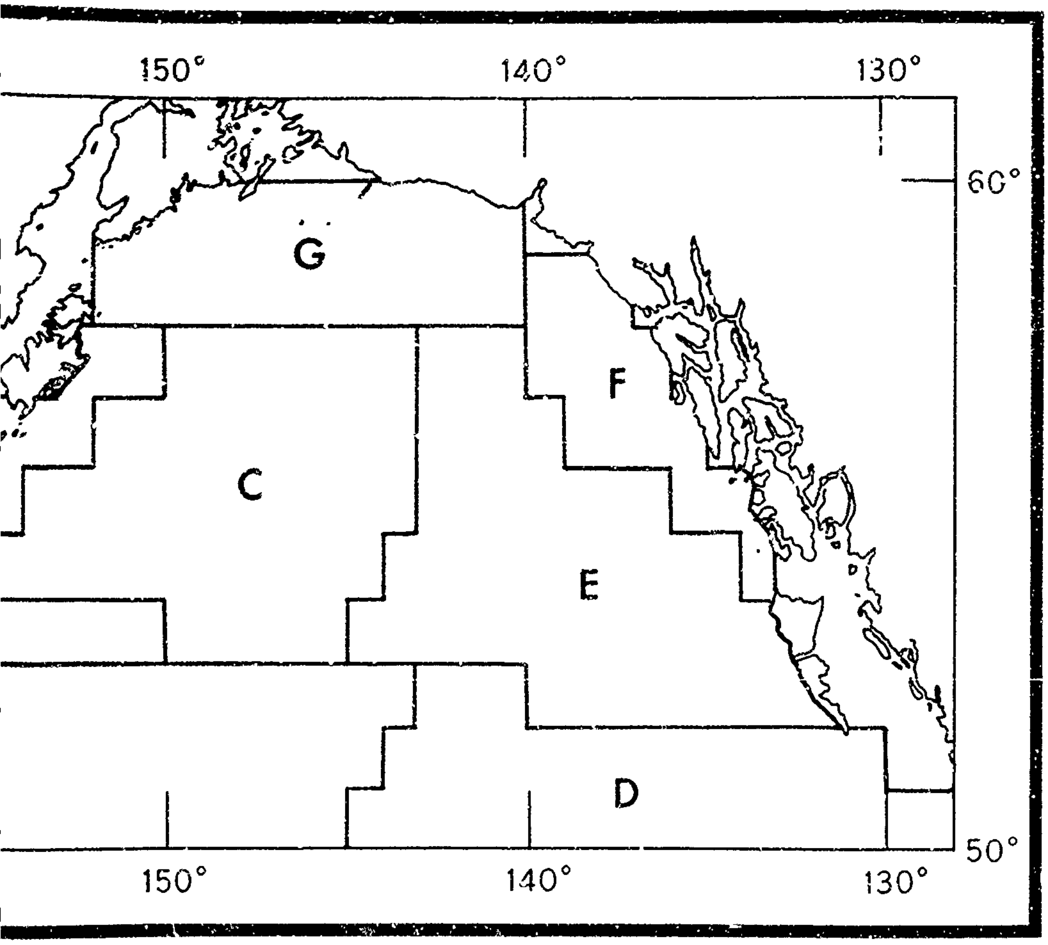

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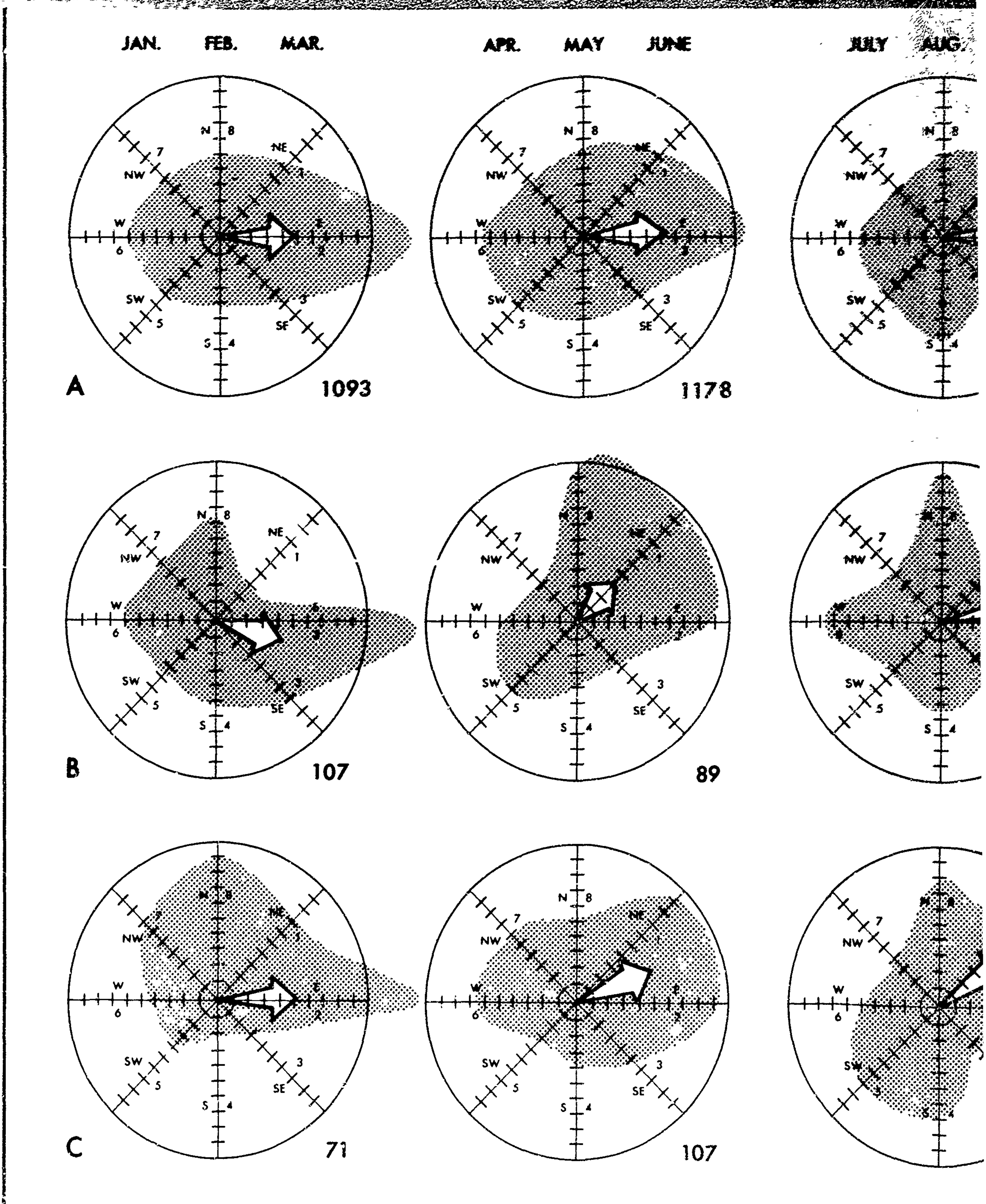
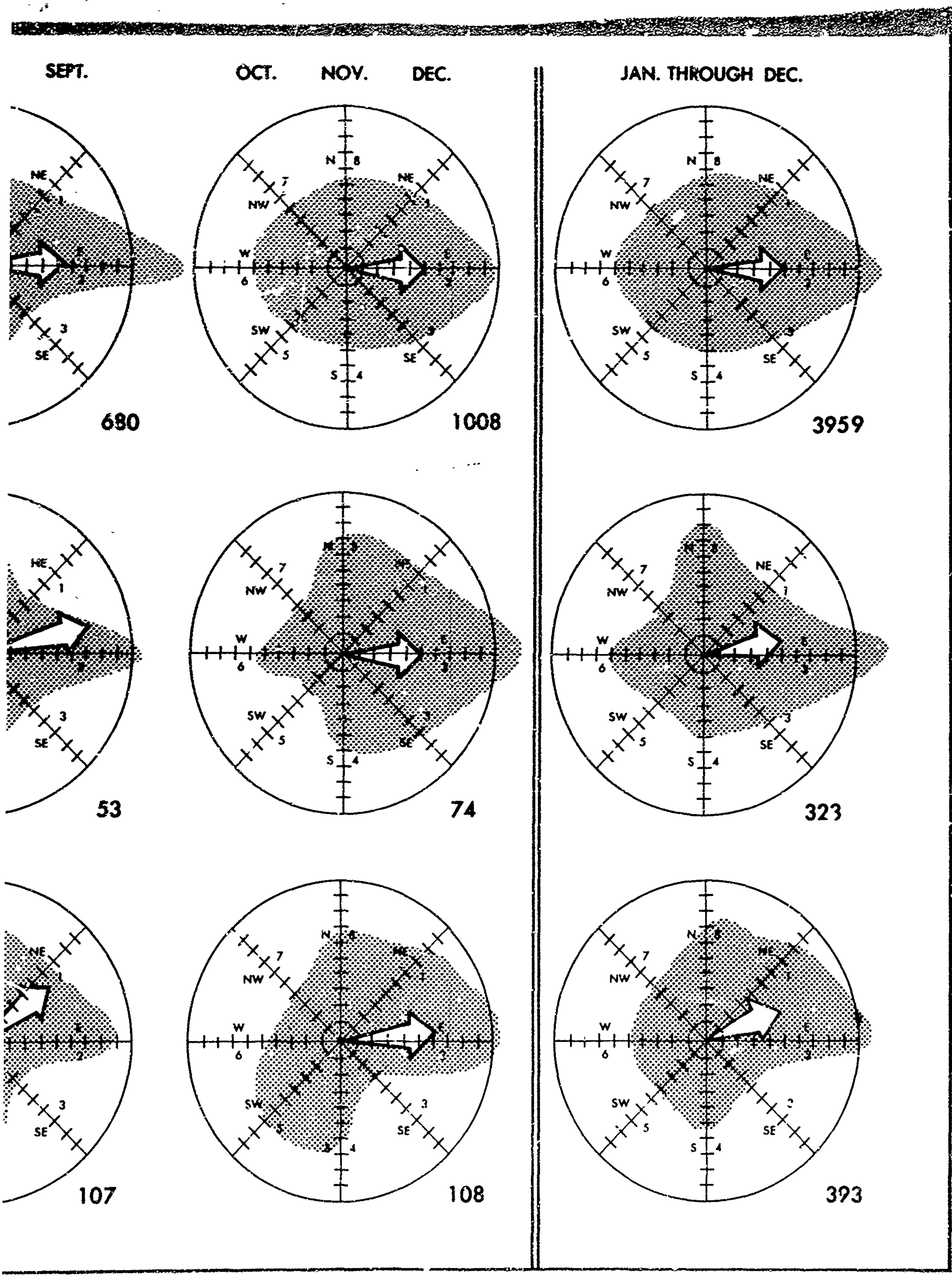
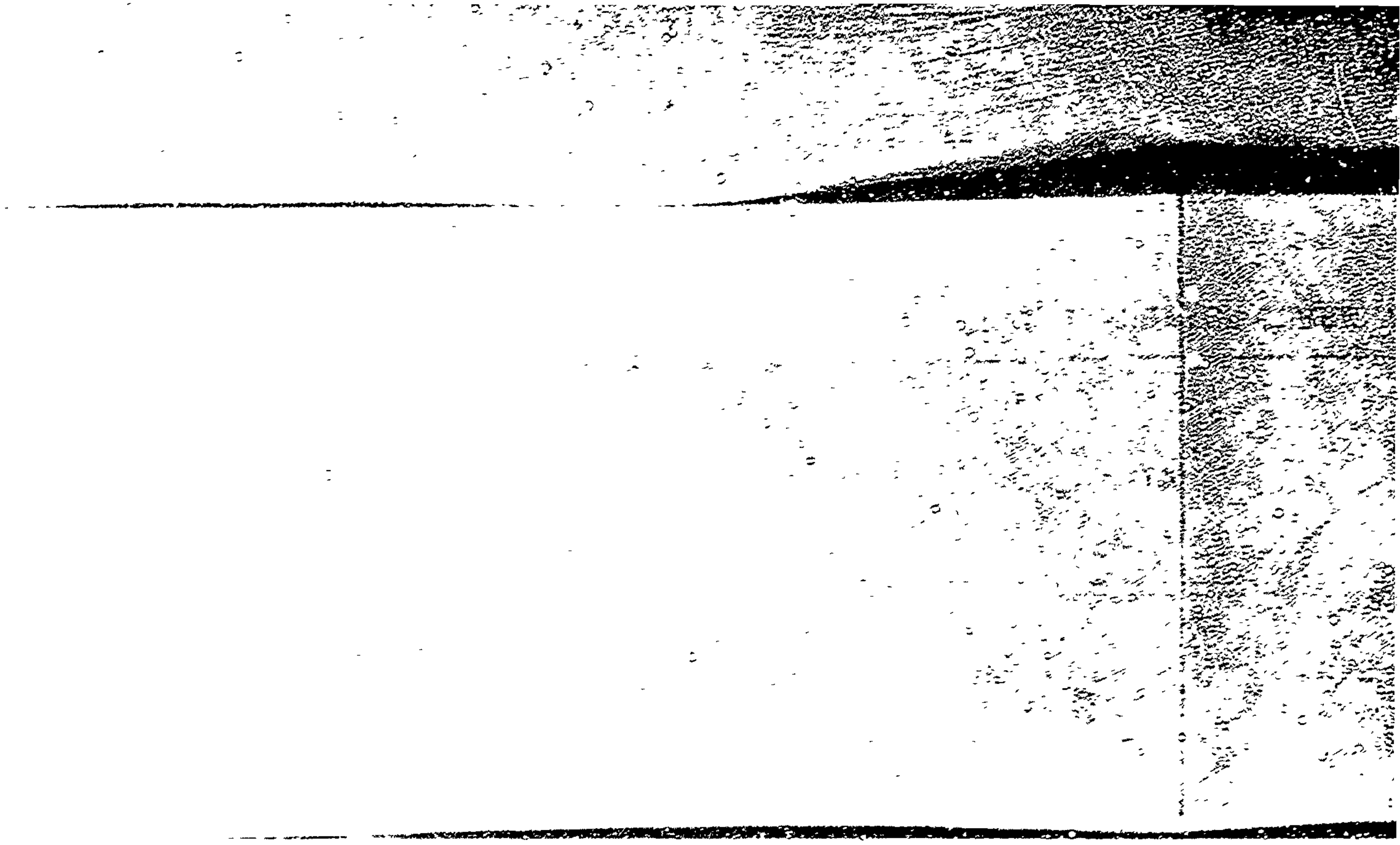
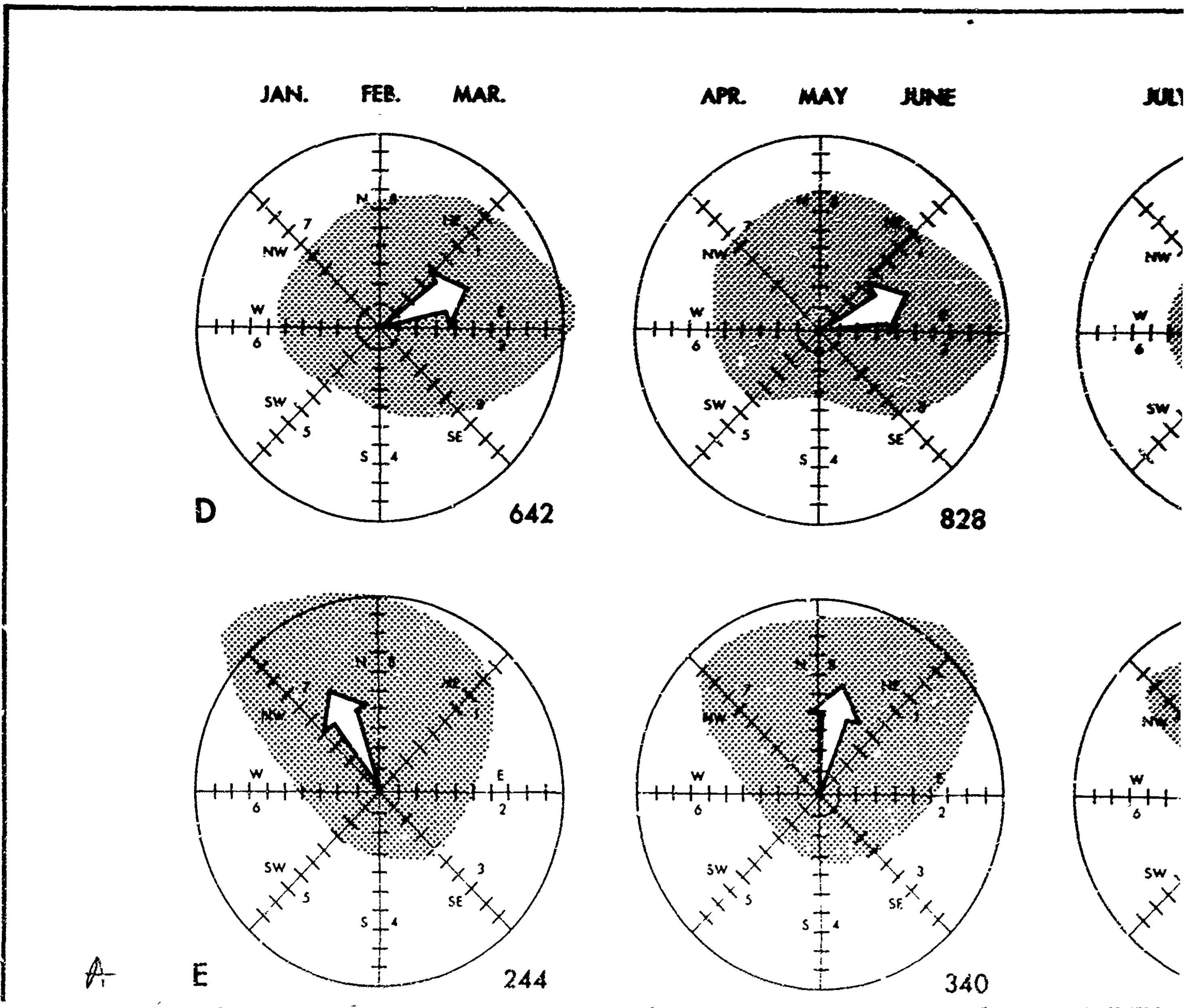


FIGURE 1 SURFACE CURRE



RENTS NORTH OF 50°N




JAN. FEB. MAR.
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E
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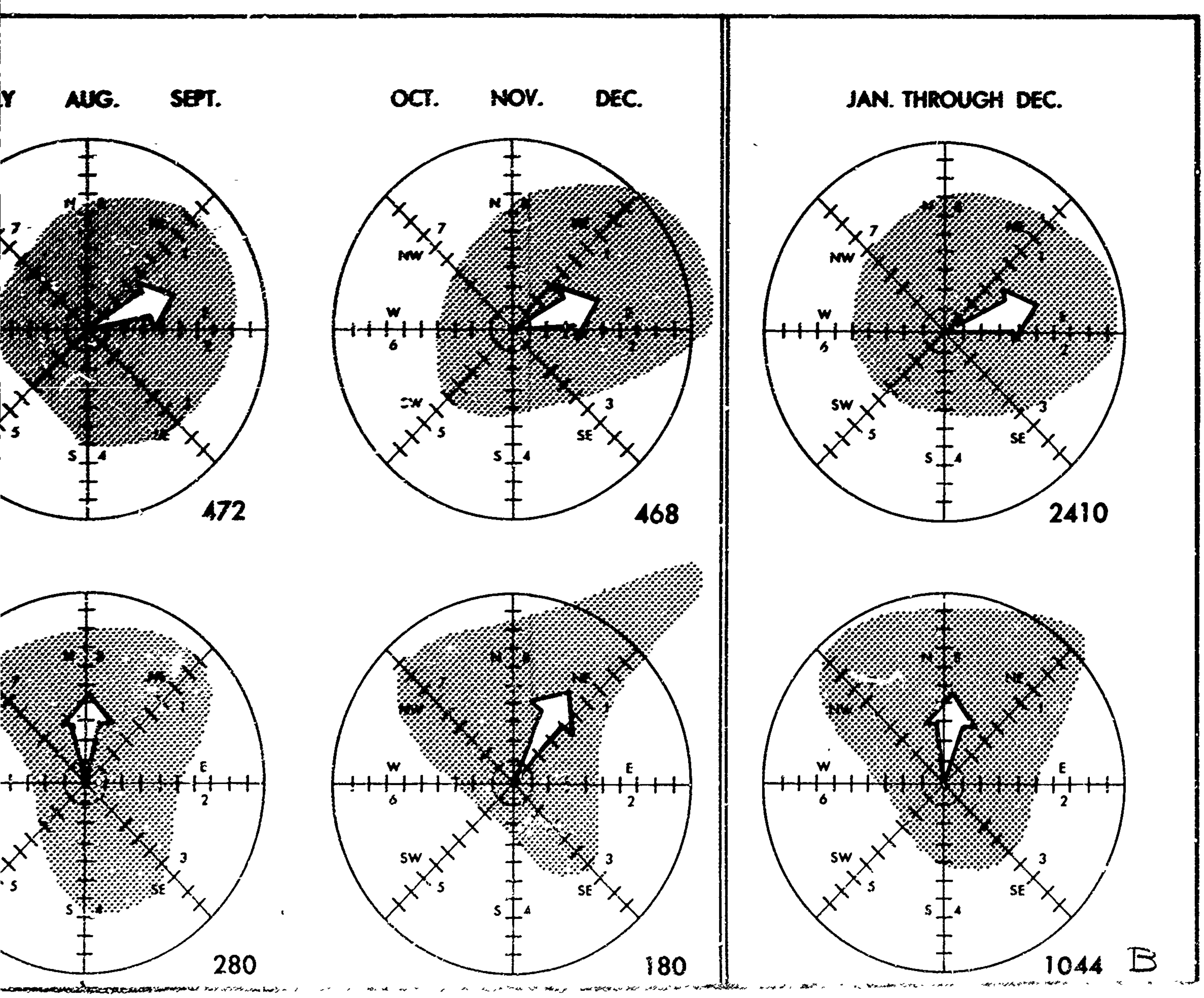
340



Y AUG. SEPT.
OCT. NOV. DEC.
JAN. THROUGH DEC.
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180
1044

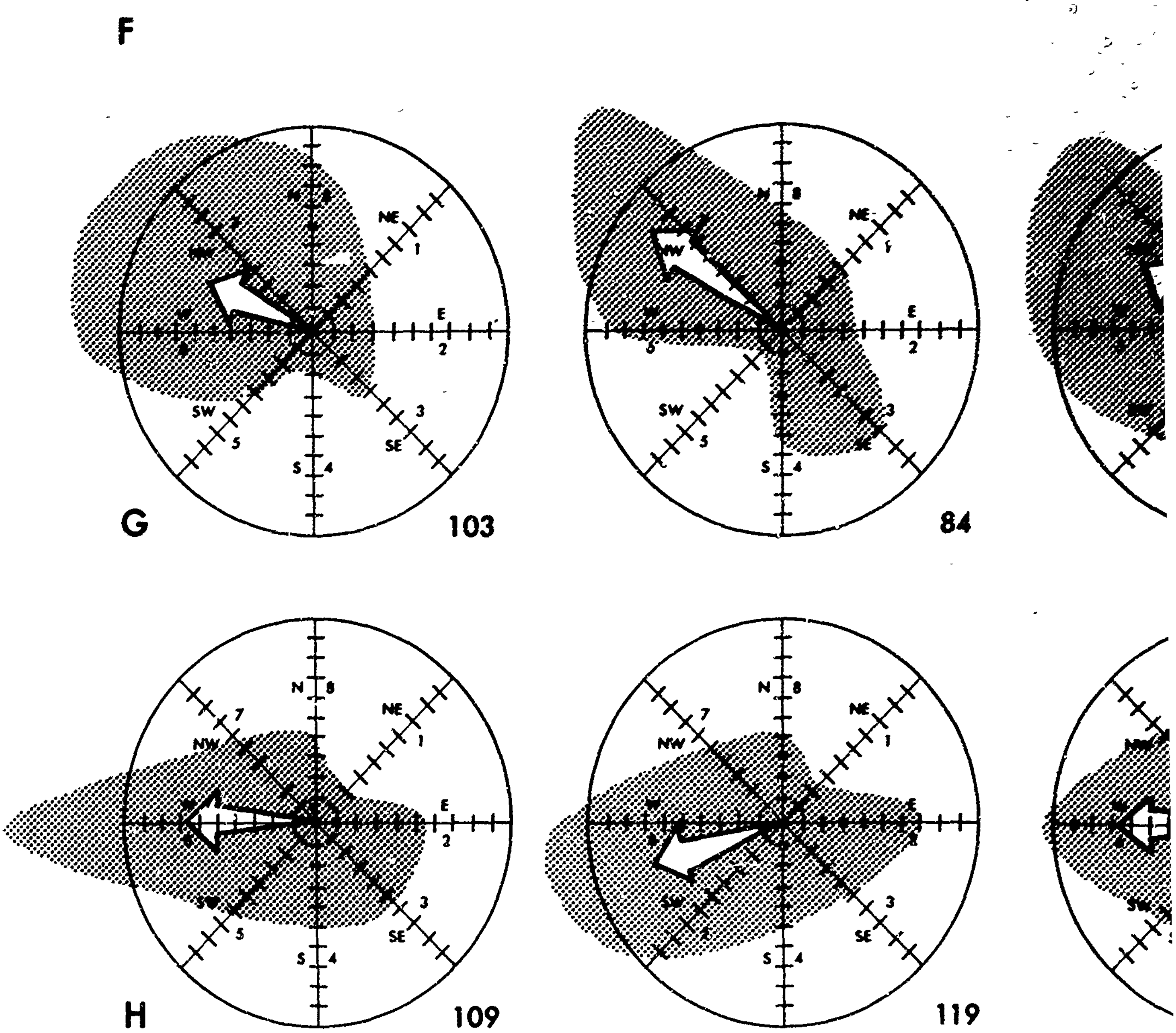

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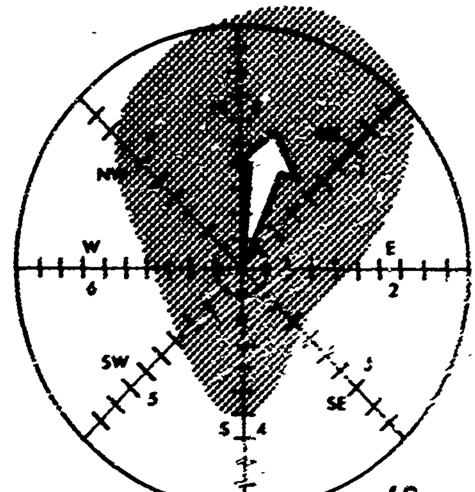
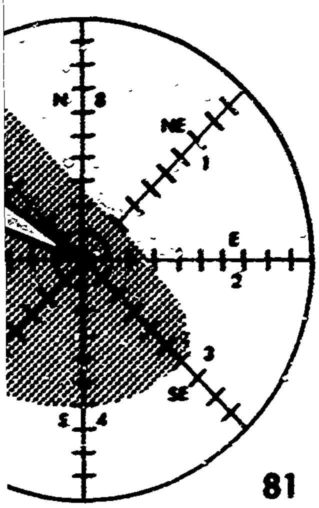
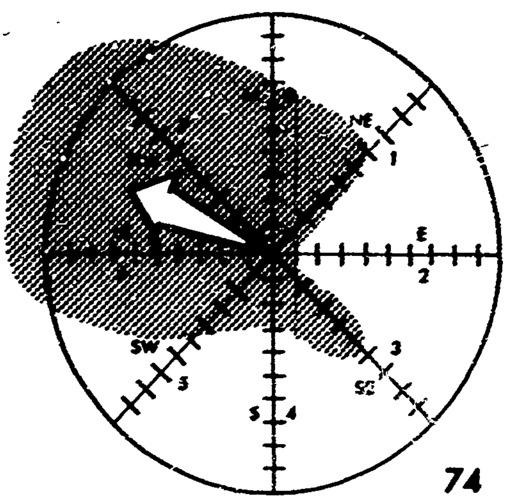
FIGURE 1 SURFACE CURREN



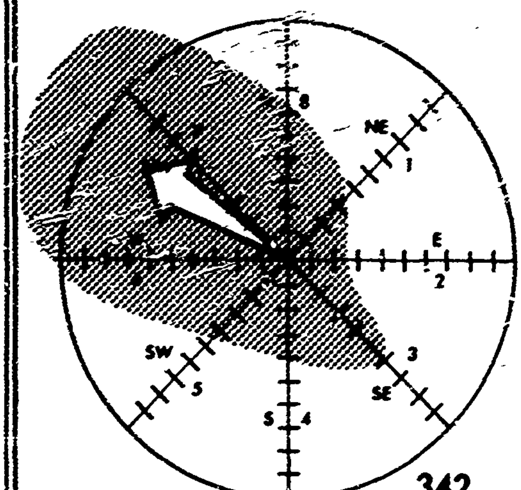
68



81



74



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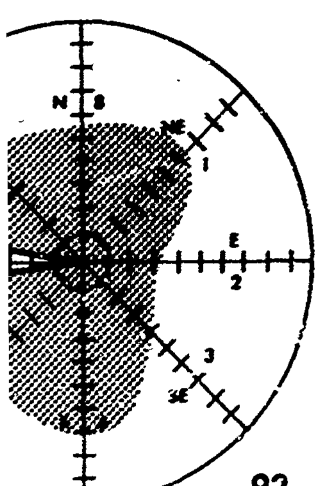
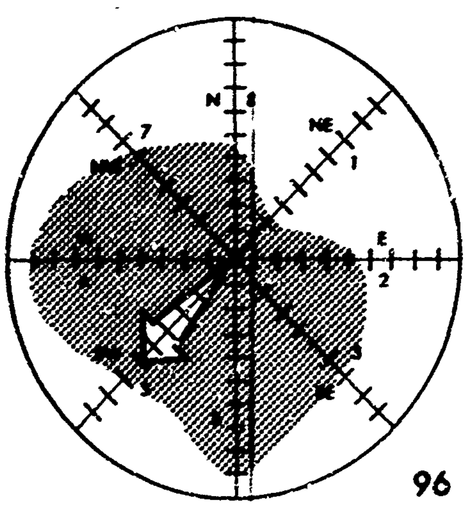


92



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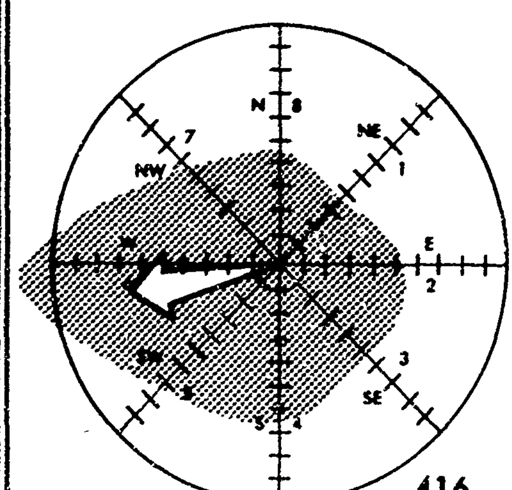


416

'S NORTH OF 50°N, CONTINUED

5

TABLE 1 DIRECTIONS AND SPEEDS OF ALASKA CURRENT IN REGIONS SHOWN IN FIGURE 1

	A				B				C				D			
	Dir.	%	Mn.	Max.	Dir.	%	Mn.	Max.	Dir.	%	Mn.	Max.	Dir.	%	Mn.	Max.
			Knots				Knots				Knots				Knots	
J F M	E	30	0.5	1.8	E	30	0.4	1.0	E	35	0.5	1.0	ENE	35	0.5	1.0
A M J	ENE	30	0.5	1.8	NE	40	0.3	0.6	ENE	35	0.4	1.0	ENE	30	0.5	1.5
J A S	EME	35	0.5	1.8	NE	35	0.7	1.7	ENE	25	0.6	1.5	ENE	30	0.5	1.4
O N D	E	30	0.5	2.0	E	35	0.5	1.0	ENE	25	0.5	1.4	ENE	40	0.5	1.3
YEAR	E	30	0.5	2.0	ENE	35	0.5	1.7	ENE	30	0.5	1.5	ENE	35	0.5	1.5

	E				F				G				H			
	Dir.	%	Mn.	Max.	Dir.	%	Mn.	Max.	Dir.	%	Mn.	Max.	Dir.	%	Mn.	Max.
			Knots				Knots				Knots				Knots	
J F M	NNW	35	0.6	1.6	Insufficient				WNW	45	0.5	1.0	WSW	35	0.6	1.3
A M J	NNE	35	0.5	1.5	Data for				WNW	50	0.8	2.0	WSW	40	0.7	1.5
J A S	N	30	0.5	1.5	Seasonal				WNW	45	0.6	1.5	WSW	25	0.6	1.4
O N D	NNE	40	0.6	1.4	Presentation				WNW	45	0.7	1.6	SW	20	0.7	1.6
YEAR	NNE	35	0.5	1.6	MME	40	0.5	1.3	WNW	45	0.7	2.0	WSW	25	0.6	1.6

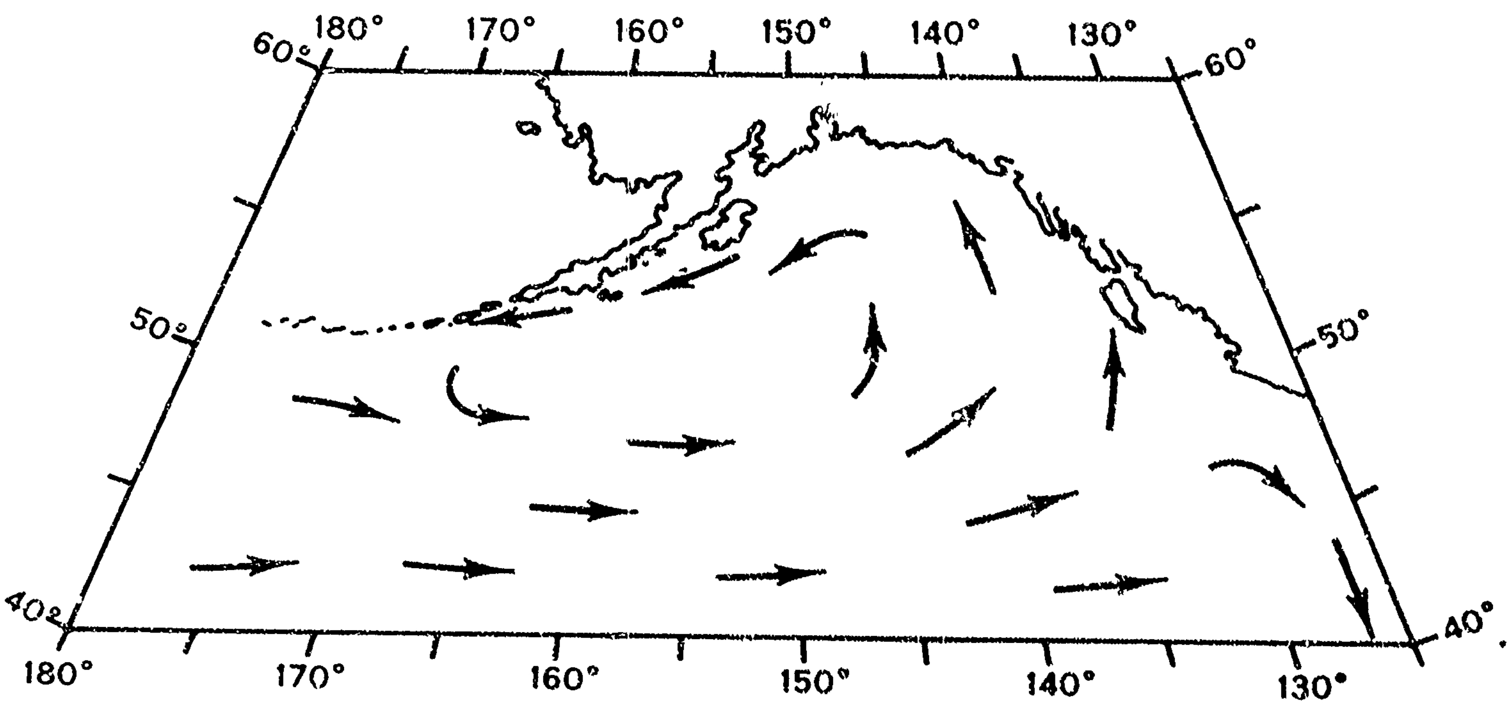


FIGURE 2 SCHEMATIC DIAGRAM OF ALASKA CURRENT

BERING CURRENT

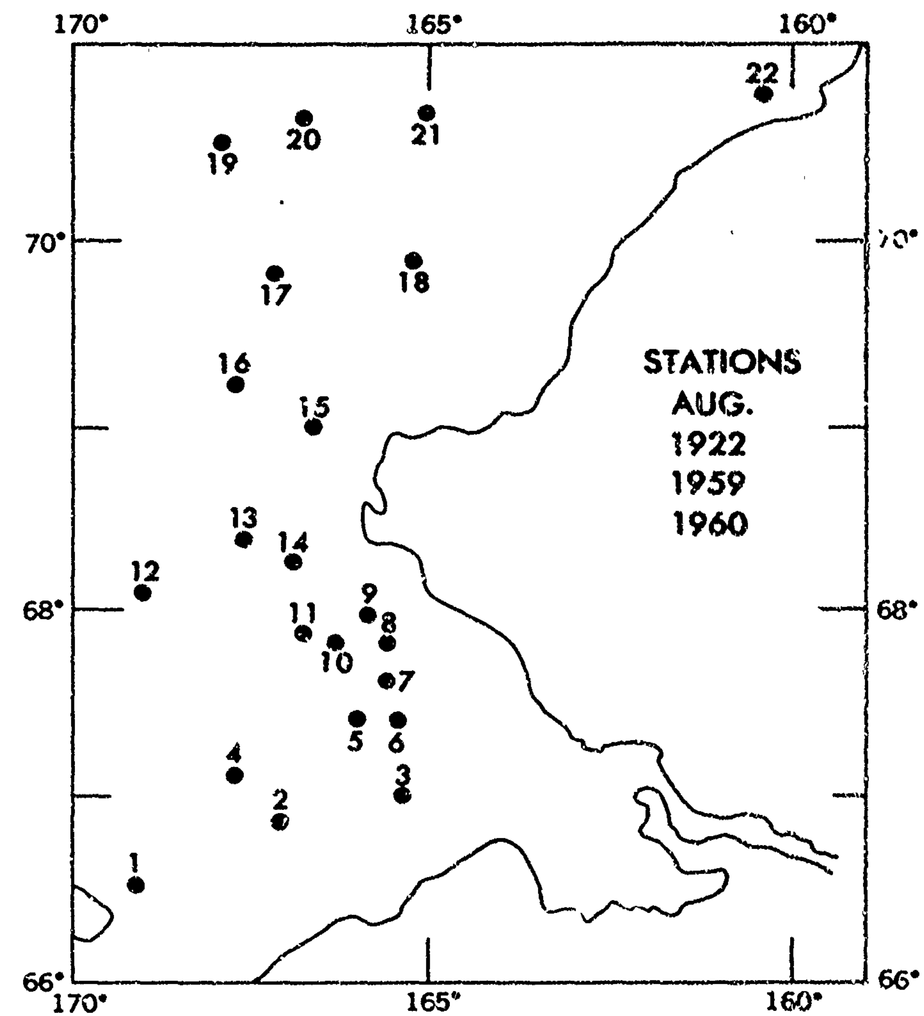
Sparse available data indicate a general north-flowing current through the eastern half of Bering Sea, through Bering Strait, and in eastern Chukchi Sea. The current originates mainly from the North Pacific Current, and its speed in the Bering Sea is estimated to be usually 0.5 knot or less but at times as high as 1.0 knot.

In Bering Strait current speeds frequently reach 2 knots; however, in the eastern half of the strait currents are even stronger and usually range between 1.0 and 2.5 knots. The volume transport of the prevailing northward flow in the strait during August was computed to be about 120 km^3 per day. Strong southerly winds may increase current speeds in the strait to 3 knots, and up to 4 knots in the eastern part; persistent strong northerly winds during autumn may cause the current to reverse for short periods. During winter a southward flow at times may occur in the western part of the strait.

After flowing through Bering Strait, the current widens, and part continues toward Point Barrow, where it turns northwest. Table 2 shows prevailing directions and speeds at the surface and near the bottom observed in August at 22 locations in the eastern part of the shallow Chukchi Sea, where 31 current meter stations were occupied. Along the Alaska coast, current speeds have been observed to range between 0.1 and 1.5 knots and increase to 2.0 or 2.5 knots with southerly winds. In the western part of the Chukchi Sea, currents are considerably weaker and do not usually exceed 0.5 knot.

TABLE 2 SURFACE AND NEAR-BOTTOM CURRENTS OFF THE COAST OF ALASKA

STA.	DIRECTION SUR	DIRECTION NEAR-BOT	SPEED (kn) SUR	SPEED (kn) NEAR-BOT	DEPTH (m) OBS	DEPTH (m) BOT
1	N	N	0.6	0.5	48	50
2	NNE	NNE	0.5	0.5	34	37
3	NE	N	0.6	0.3	35	35
4	ENE	NE	0.5	0.4	30	30
5	NNE	NNE	0.3	0.2	30	40
6	NNE	N	0.5	0.4	34	34
7	NW	NW	1.0	0.6	35	39
8	WNW	NW	1.1	0.6	35	35
9	NW	WNW	0.6	0.4	30	32
10	NW	WNW	1.2	0.6	45	48
11	N	N	0.8	0.6	45	50
12	WNW	WNW	0.7	0.5	50	55
13	NNE	NNW	1.0	0.3	42	45
14	N	WNW	0.7	0.3	31	35
15	NE	NNE	1.1	0.3	35	38
16	NE	ENE	0.7	0.1	46	46
17	N	NE	0.8	0.4	42	45
18	--	--	0.4	0.4	30	33
19	NNE	N	0.6	0.4	40	50
20	NE	NNW	0.5	0.5	37	40
21	NE	NE	0.6	0.4	42	45
22	NE	N	1.5	0.7	25	29



LOCATION CHART

Figure 3A is a composite of 15 current stations in August in the eastern part of Bering Strait; the flow ranges between west-northwest and north-northeast and indicates persistent speeds ranging between 0.2 and 2.1 knots. Figure 3B is a composite of eight current stations in the western part of the strait; the flow there is weaker but still persists between west-northwest and north between 0.4 and 1.4 knots. The current in the Chukchi Sea is augmented by the East Siberian Coastal Current, which joins the north-setting Bering Current north of East Cape.

Northeast of Wrangel Island, in the vicinity of 72°N, 175°W, five current meter stations showed the current to be outside the limit of the northeast flow. The current near the surface appeared to be mainly tidal, changing direction periodically; the tidal effect lessens considerably to a depth of 40 meters and disappears near the bottom.

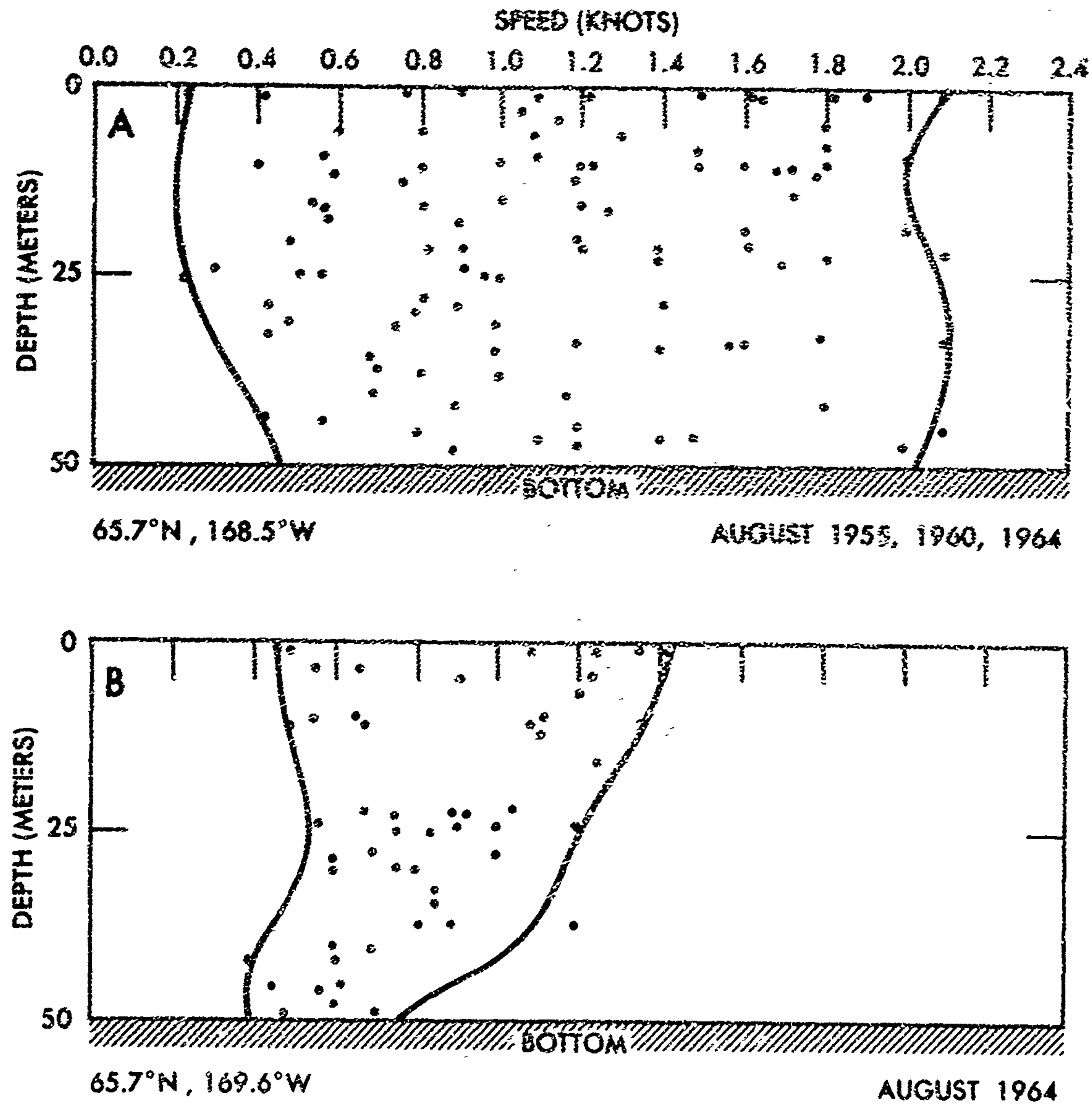


FIGURE 3 SUBSURFACE CURRENT SPEEDS IN BERING STRAIT

CALIFORNIA CURRENT

Usually described as a permanent ocean current, the California Current is actually a poorly defined and variable southerly flow easily influenced by the wind. Figure 4 shows the boundaries within which the southward flow is observed, particularly during March through September when the current extends to the coast and includes the region usually occupied by the Davidson Current during winter. Table 3 indicates the variability of flow of the California Current by season in regions A and B, and for the months when the current is observed in coastal regions C and D. Part of the south-setting California Current is observed within the near-coastal Davidson Current during winter.

It is evident from these data that even during summer, when the California Current is most constant, it tends to be variable. In region A the current sets directly south 23 percent of the time; all other directions average about 10 percent. In region B the current sets generally southeast through south to southwest 58 percent of the time; other directions average 8 percent.

During winter in region A the current sets directly south only about 19 percent of the time; it has little stability as significant percentages of observations indicate north, east, southeast, and west flows. In region B the current sets generally southeast through south to southwest about 48 percent of the time; other directions average 10 percent, with no significant secondary flow.

The minimum flow of 19 percent southward in region A during winter coincides with the winds in the vicinity of 40°N, which

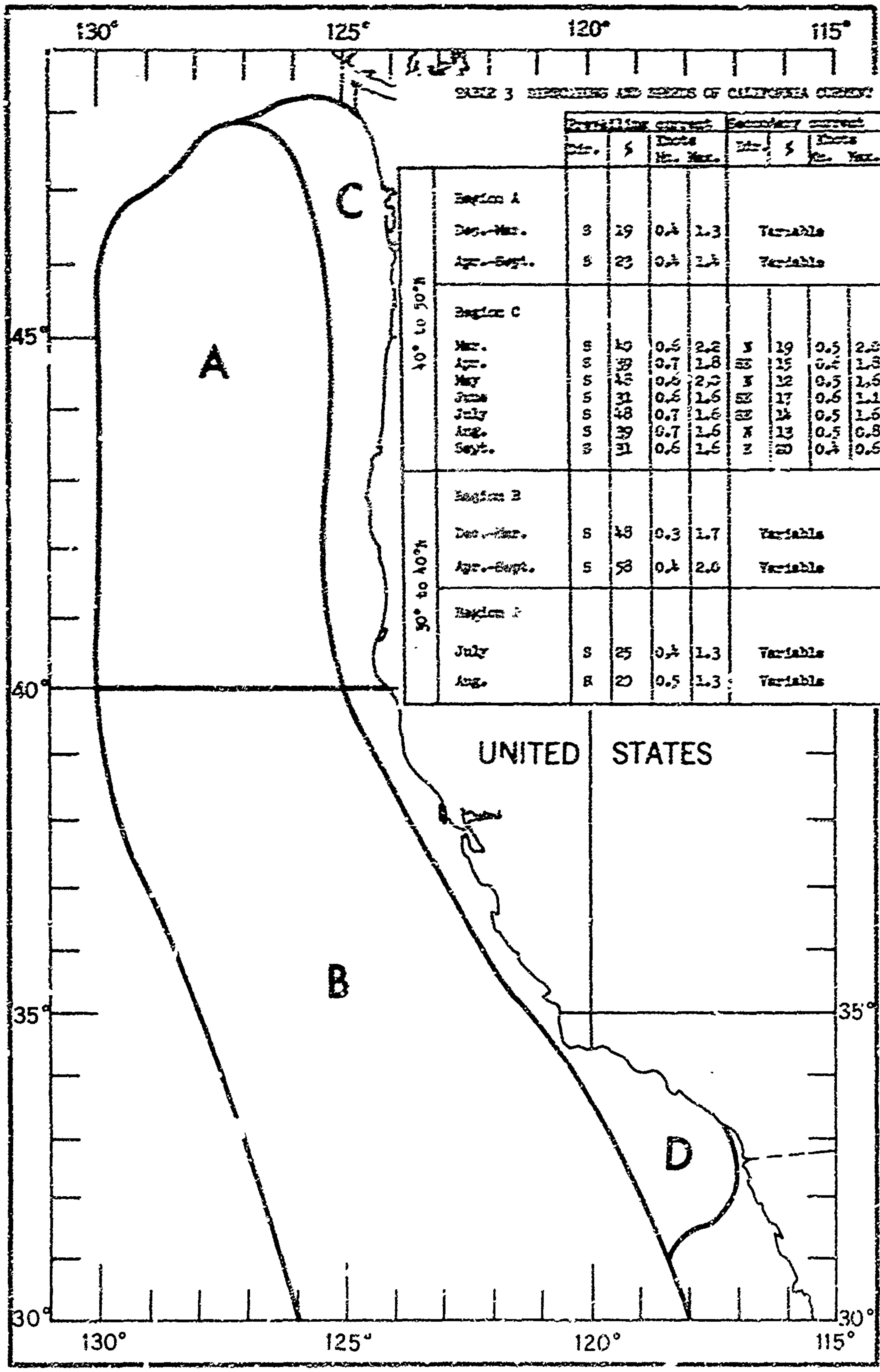


TABLE 3 DIRECTIONS AND SPEEDS OF CALIFORNIA CURRENT

		Prevailing current				Secondary current				
		Dir.	%	Knots Mn.	Max.	Dir.	%	Knots Mn.	Max.	Total obs.
40° to 50°N	Region A									
	Dec.-Mar.	S	19	0.4	1.3	Variable				426
	Apr.-Sept.	S	23	0.4	1.4	Variable				804
	Region C									
	Mar.	S	40	0.6	2.2	N	19	0.5	2.0	692
	Apr.	S	39	0.7	1.8	[illegible]	15	0.4	1.8	1621
	May	S	45	0.6	2.0	N	12	0.5	1.6	711
	June	S	31	0.6	1.6	[illegible]	17	0.6	1.1	1162
	July	S	48	0.7	1.6	[illegible]	14	0.5	1.6	1524
	Aug.	S	39	0.7	1.6	N	13	0.5	0.8	1225
	Sept.	S	31	0.6	1.6	N	20	0.4	0.6	1333
30° to 40°N	Region B									
	Dec.-Mar.	S	48	0.3	1.7	Variable				4,551
	Apr.-Sept.	S	58	0.4	2.0	Variable				6,970
	Region D									
	July	S	25	0.4	1.3	Variable				529
	Aug.	S	20	0.5	1.3	Variable				496

FIGURE 4 BOUNDARIES OF CALIFORNIA CURRENT

dominate from southeast through southwest during December and January only; winds prevail from northwest and north-northwest in all other months.

In region C the flow is definitely south from March through September; flow is more constant, percent frequencies are higher, and speeds are stronger than in region D, where flow is more variable. The southward flow is most constant in region D during July, although the frequency is only 25 percent compared to less than 13 percent in any of the other seven directions.

CAPE HORN CURRENT

The Cape Horn Current sets continuously eastward close to the tip of South America and enters Drake Passage at about 70°W in a 150-mile-wide band, with surface speeds up to 2.4 knots. The set veers north-northeast, and when it crosses longitude 65°W the current has narrowed to a width of about 85 miles and its speed has decreased considerably.

The profiles of computed speeds in Figure 5 show the well-defined limits of the current. Available data indicate a fairly high rate of transport for this current, averaging about 370×10^9 m^3/hr in the western part and 224×10^9 m^3/hr in the eastern part.

The current profile shown in Figure 6 indicates the usual range of speed and the set that can be expected in Drake Passage.

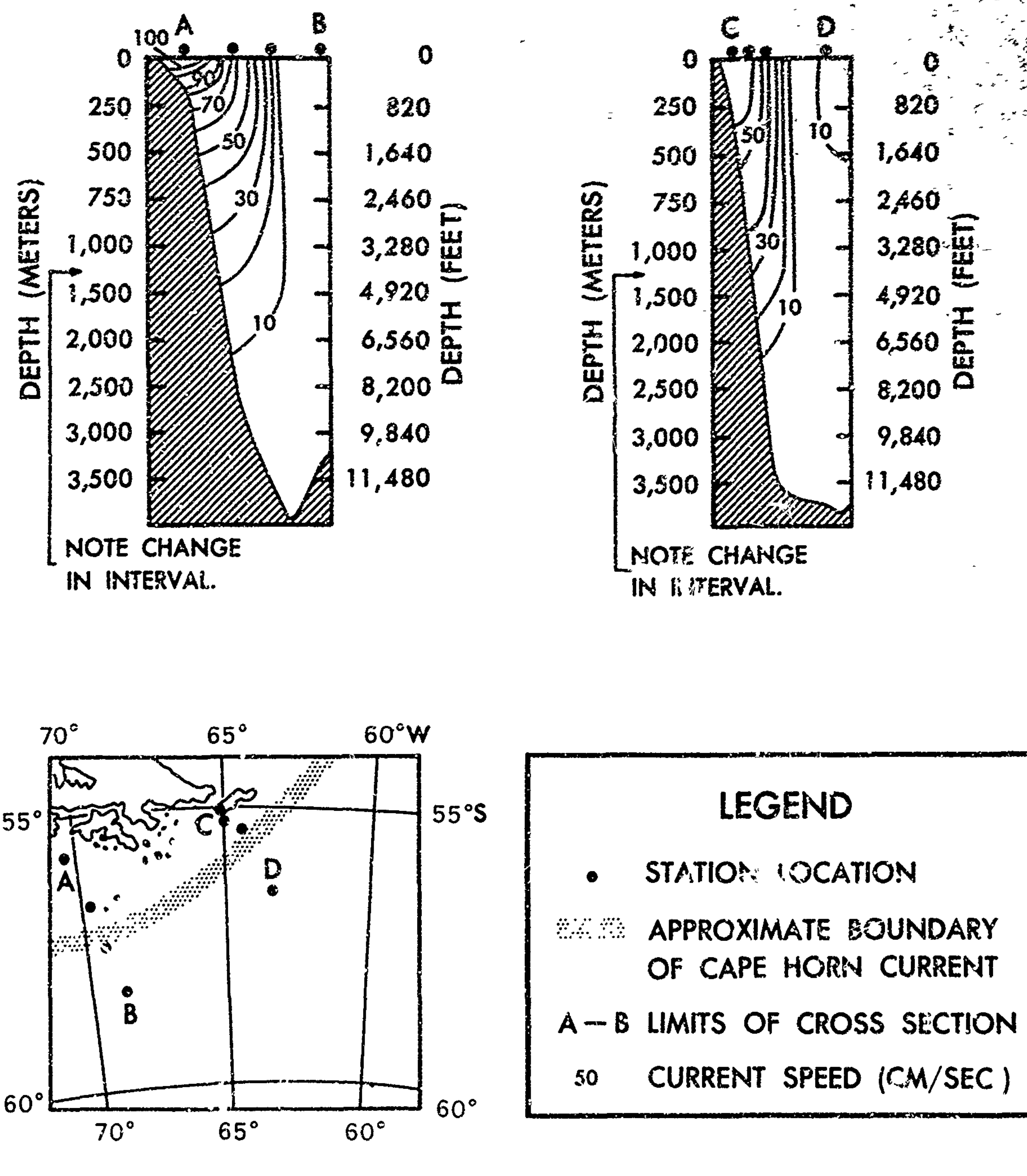


FIGURE 5 COMPUTED CURRENT SPEED PROFILES, CAPE HORN CURRENT

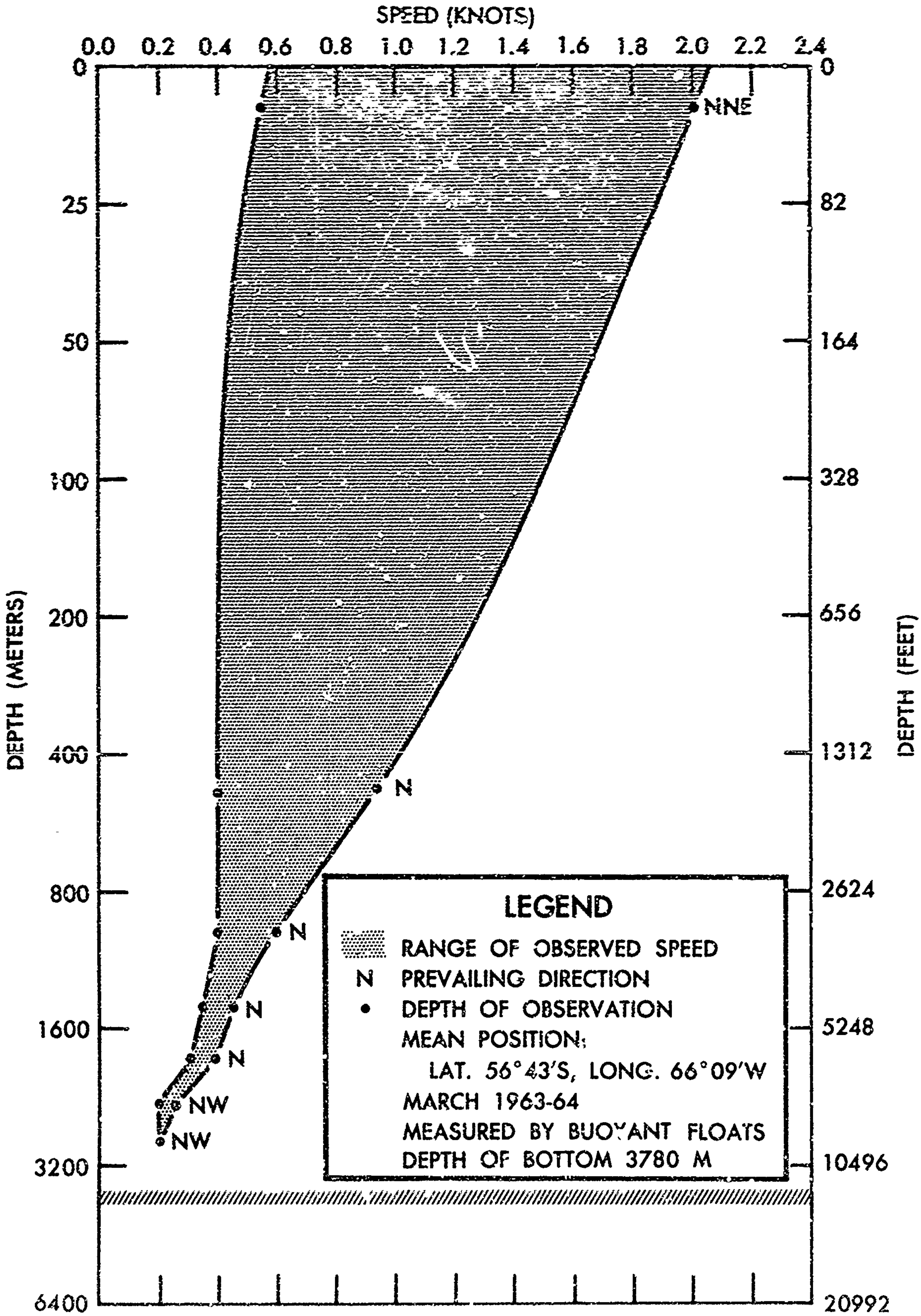


FIGURE 6 OBSERVED CURRENT PROFILE, CAPE HORN CURRENT

DAVIDSON CURRENT (Winter Coastal Countercurrent)

The Davidson Current is not a permanent ocean current but rather a seasonal countercurrent that sets northward at all depths close to the Pacific coast of the United States north of 32°N. Available data indicate that this flow should be more accurately referred to simply as the Winter Coastal Countercurrent; it is a poorly defined and variable flow dependent mainly upon the influence of the wind.

Figure 7 shows the boundary within which the prevailing northward flow most frequently occurs; it becomes best established in January. Table 4 indicates the variability of flow by showing the monthly percent frequency of observations of speed and direction. The Davidson Current is interrupted by the prevailing south flow of the California Current from March through the first half of October.

The southern part of the Davidson Current, region B, is more variable than the northern part; although the prevailing flow is northward during winter, the data show that sets in the opposite direction occur frequently in January and February. During July, under the influence of the California Current, the southward flow is most constant although the frequency is only 25 percent compared to less than 13 percent in any of the other seven directions. Calms average 8 percent and are twice those in region A, where the flow is more constant.

In region A the current turns from south to north during October, when considerable variability occurs; the northward set increases in constancy through January, when the frequency of southward sets is about 17 percent. The current appears to set

northward through the early part of February and then to become variable as it begins to turn, as indicated by the distribution of east and south flows totaling about 36 percent. From March through September the strong southward flow is an extension of the California Current; percent frequencies are higher and speeds are stronger than in region B. The tabulated data indicate that part of the south-setting California Current is also observed throughout both regions during winter.

The pronounced northward flow in winter coincides with the winds in the vicinity of 40°N, which predominate from southeast through southwest only during December and January; they prevail from northwest and north-northwest in all other months. Table 5 shows the winds which can influence the current off the west coast of the United States in December. The more frequent south and southeast winds in region A will increase the constancy of the north-setting current, whereas the more frequent northwest and north winds in region B will cause the current to be more variable.

Drift bottles were released off the coast between 42° and 46°N between June 1959 and October 1963. The results generally agree with the surface drift data in Table 4; over 70 percent of the returns were from bottles released within 40 miles of shore, and the northward flow was apparent during November through February in all years.

Direct surface current measurements during March have indicated a southeast flow within 30 miles of shore in the vicinity of 36°30'N, 122°15'W; in this region subsurface drogue measurements at

TABLE 4 DIRECTIONS AND SPEEDS OF DAVIDSON AND CALIFORNIA CURRENTS

REGION A. 40°-48°N	PREVAILING CURRENT DIR.	%	Mn. (Knots)	Max. (Knots)	SECONDARY CURRENTS DIR.	%	Mn. (Knots)	Max. (Knots)	TOTAL Obs.
JAN	N	31	0.6	1.9	S	16	0.5	1.1	178
FEB	N	29	0.6	1.6	E	19	0.5	1.3	182
					S	17	0.4	0.9	--
MAR	S	40	0.6	2.2	N	19	0.5	2.0	692
APR	S	39	0.7	1.8	SE	15	0.6	1.8	162
MAY	S	48	0.6	2.0	N	12	0.5	1.6	711
JUN	S	31	0.6	1.6	SE	17	0.6	1.1	148
JUL	S	48	0.7	1.6	SE	14	0.5	1.6	152
AUG	S	39	0.7	1.6	N	13	0.5	0.8	126
SEP	S	31	0.6	1.6	E	20	0.4	0.6	133
OCT	S	23	0.5	1.5	E	13	0.5	1.0	143
	N	23	0.5	1.2	W	10	0.4	0.6	--
NOV	N	38	0.5	1.7	S	23	0.4	1.1	583
DEC	N	28	0.6	1.4	S	19	0.4	0.9	157
B. 32°-40°N									
JAN	N	17	0.5	1.7	other directions				622
	S	16	0.5	1.4	less than			16%	--
FEB	N	18	0.5	1.4					565
	S	14	0.4	1.3	"	"		14%	--
JUL	S	25	0.4	1.3	"	"		13%	529
AUG	N	20	0.5	1.3					496
	N	16	0.5	1.4	"	"		13%	--

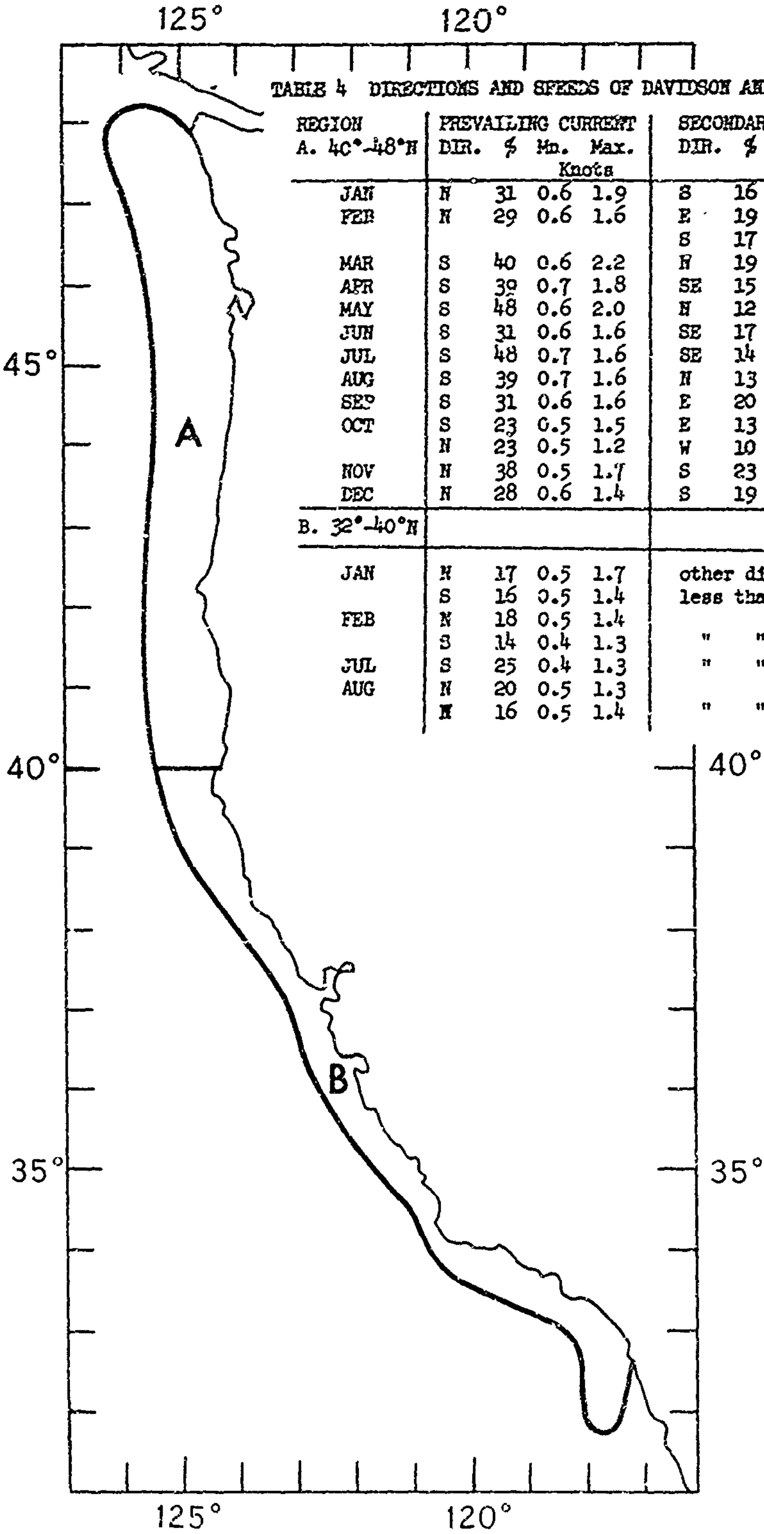


FIGURE 7 BOUNDARIES OF DAVIDSON CURRENT

250 meters showed a northward flow about 40 miles wide at speeds of about 0.5 knot. These seem to verify various reports that there is a northward flow inshore throughout the year at depths below 200 meters. Above 200 meters the north-setting countercurrent that develops when winds weaken or are southerly appears to be part of the deep countercurrent.

When northerly winds become weak or negligible in late autumn and winter, a north-setting countercurrent forms at the surface well inshore of the main south-setting California Current. During this period upwelling lessens and numerous irregular eddies may occur along the coast. There is evidence that the nearshore countercurrent may be influenced by coastal tidal currents observed from 5 to 20 miles offshore; these tidal currents are rotary and change direction continually, so that during a tidal cycle they will have set in all directions of the compass, with speeds varying according to lunar phase or wind effect.

TABLE 5 OFFSHORE WINDS IN THE VICINITY OF 40°N, DECEMBER

REGION A			REGION B		
Dir. FROM	%	MEAN SPEED (KN)	DIR. FROM	%	MEAN SPEED (KN)
S	20	14	NW	30	8
SE	16	12	N	14	8
N	15	13	SE	13	9
NW	12	6	-	-	-

EL NIÑO

The name El Niño is generally identified with large-scale disturbances which occur in the northern part of the Peru Current in certain years, reported to be at intervals of about every seven years. However, El Niño is believed to be a local term for a current that has been observed in late December for many years.

In December the northerly winds blowing across Central America reach farther south and drive water from the Gulf of Panama southward along the Peru coast. This current flows southward in a tongue-shaped band 1 to 2 miles wide between 3° and 6°S. The intensity of this phenomenon increases considerably in some years and influences a larger part of the northern nearshore portion of the Peru Current. During such periods the Peru Current retards, the temperature of the surface water rises sharply, and the southward flow comes as far as 20°S. This condition, most commonly referred to as El Niño, results in a layer of warm water about 75 feet deep and as wide as 20 miles.

Although the origin of this flow is not definitely known, it is believed that northwesterly winds that penetrate farther south than usual cause the Peru Current to weaken; close to shore a south-setting flow develops as the cool Peru Current is replaced by warm water with characteristics similar to those of the Pacific Equatorial Countercurrent. Mass mortality of marine organisms results when the cold and warm waters coverge.

The southward excursion of El Niño is most prevalent in January through March, when it is halted by the reappearance of southeasterly trade winds and the re-establishment of upwelling

along the coast. The complicated pattern of upwelling and wind results in variable current speeds between zero and 1.5 knots near 13°42'S and a mean speed of 0.4 knot between 22°36' and 33°00'S. Countercurrents may occur near shore.

Years during which El Niño has been recorded with greater than usual intensity are: 1891*, 1911, 1918, 1922, 1925*, 1932, 1939, 1941*, 1953, 1957, 1965, 1967.

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*Exceptionally strong

MENTOR CURRENT (Peru Oceanic Current)

The Mentor Current, named after the German ship that observed it in 1833, originates mainly from the easternmost extension of the South Pacific Current (located north of the West Wind Drift) at about 40°S, 90°W. It sets north and northwest and has the characteristic features of a drift in that it is a broad, slow-moving flow that extends about 900 miles westward from the Peru Current to about 90°W at its widest section and tends to be easily influenced by winds. It joins the west-setting South Equatorial Current and completes the anticyclonic movement in the eastern part of the South Pacific Ocean. The speed in the central part of the current at about 26°S, 80°W may at times attain about 0.9 knot.

A seasonal current rose for a region within the center of the current, shown in Figure 8, indicates a significant percent frequency of westward flow, which becomes greater westward as current speed decreases. Comparison of this rose with the rose for region 2 in the adjacent Peru Current shows the differences in speed and direction between the two currents.

Very little is known of deepwater flow in the eastern South Pacific Ocean, and estimates of speed and volume transport are necessarily approximate. Indirect observations made at a depth of 3,500 meters in the southern part of the Mentor Current at about 39°S, 84°W indicate a probable weak, uniform movement northward up to 0.05 cm/sec; volume transport of Pacific deep water from the Antarctic is estimated at about 15 x 10^6 m^3/sec.

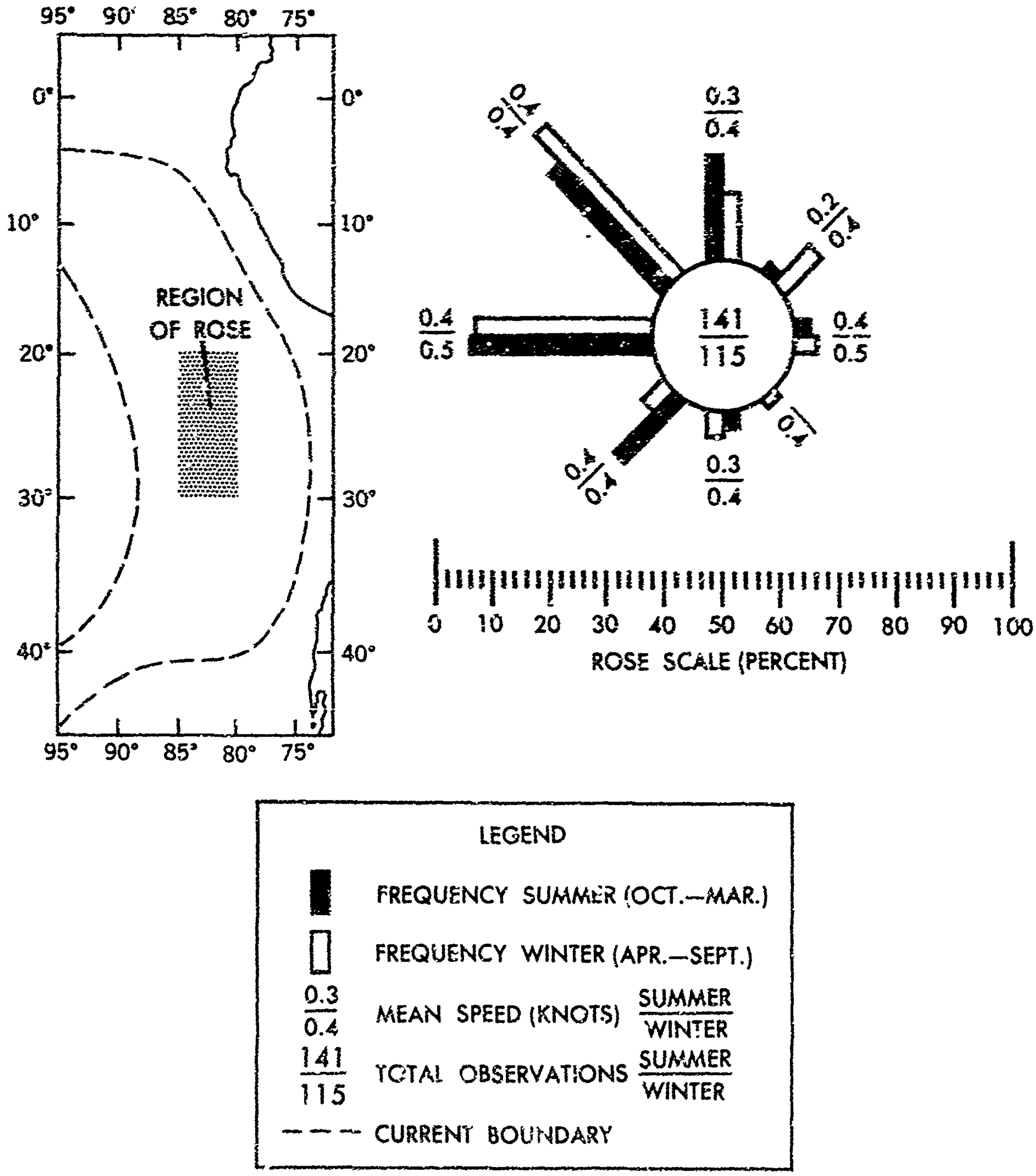

FIGURE 8 DIRECTIONS, SPEEDS, AND BOUNDARIES OF MENTOR CURRENT

PERU CURRENT (Peru Coastal Current, Humboldt Current)

The Peru Current is a narrow, fairly stable current that flows northward close to the South American coast. Knowledge of this current dates from 1522, and its nomenclature has been confused for years; the original synonymous term "Humboldt Current," based on Humboldt's observations in 1802, may be more appropriate since the current originates from the central portion of Chile at about 40°S and flows past Peru and Ecuador to the southwest extremity of Colombia.

The Peru Current has been identified as occupying two distinct regions; the inshore current often is referred to as the Peru Coastal Current, and the offshore current is described as the Peru Oceanic Current. However, these terms have been used arbitrarily, and the distinction is made principally from the biological characteristics in the upper layers. In this report the Peru Current is shown in Figure 9, and the limits are based on persistence and speed derived from thousands of surface drift observations.

Although identified in some references as the most outstanding current in the Southern Hemisphere, the Peru Current is not very strong but has a mean speed of 0.9 knot in the northern region where the flow is most persistent. The surface flow extends to about 300 meters, and the volume transport is estimated to be 26.8×10^6 m^3/sec at about 5°S.

The Peru Current is a relatively cool flow that originates from water of the South Pacific Current and the West Wind Drift where these

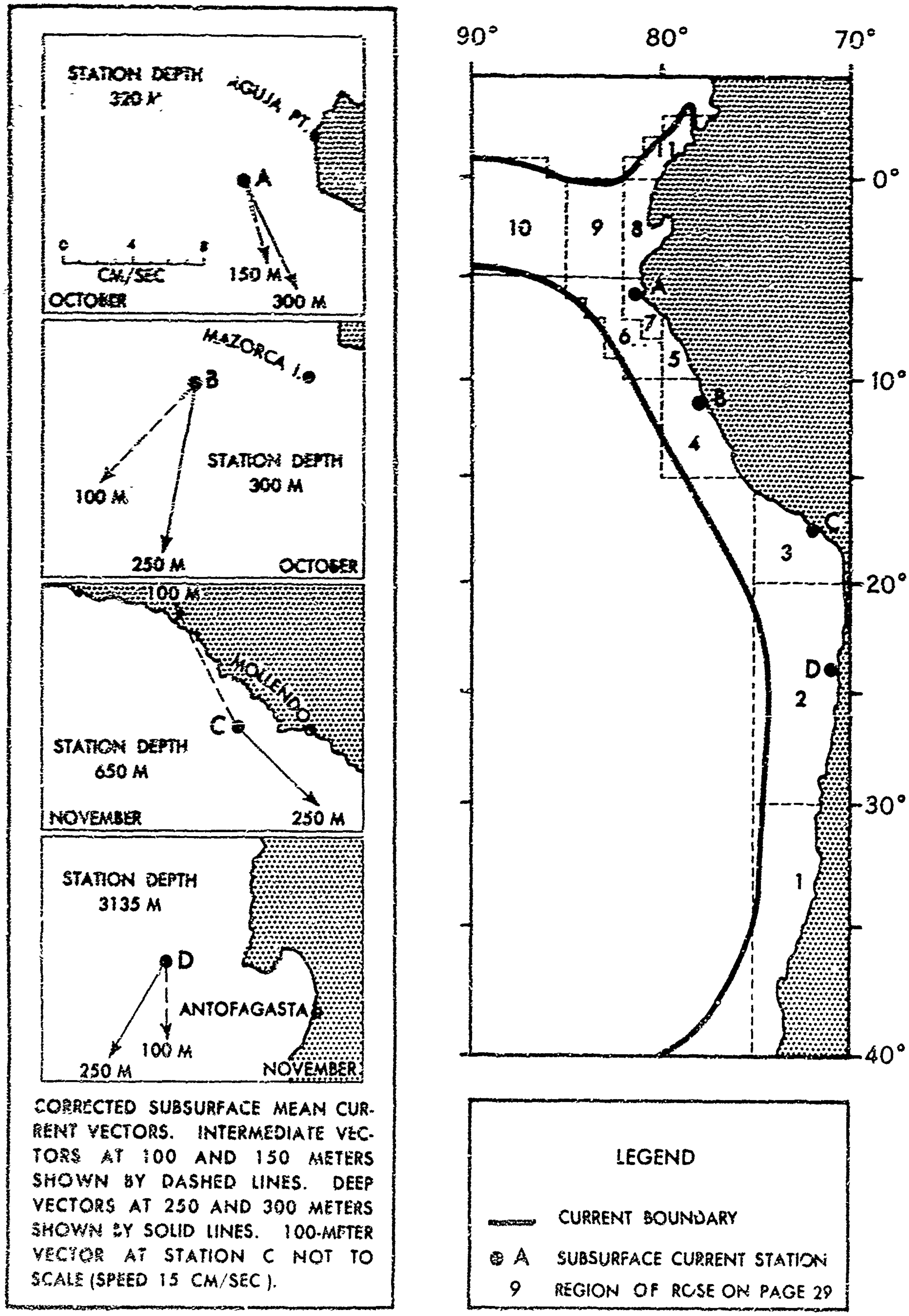

FIGURE 9 SURFACE AND SUBSURFACE FLOW OF PERU CURRENT

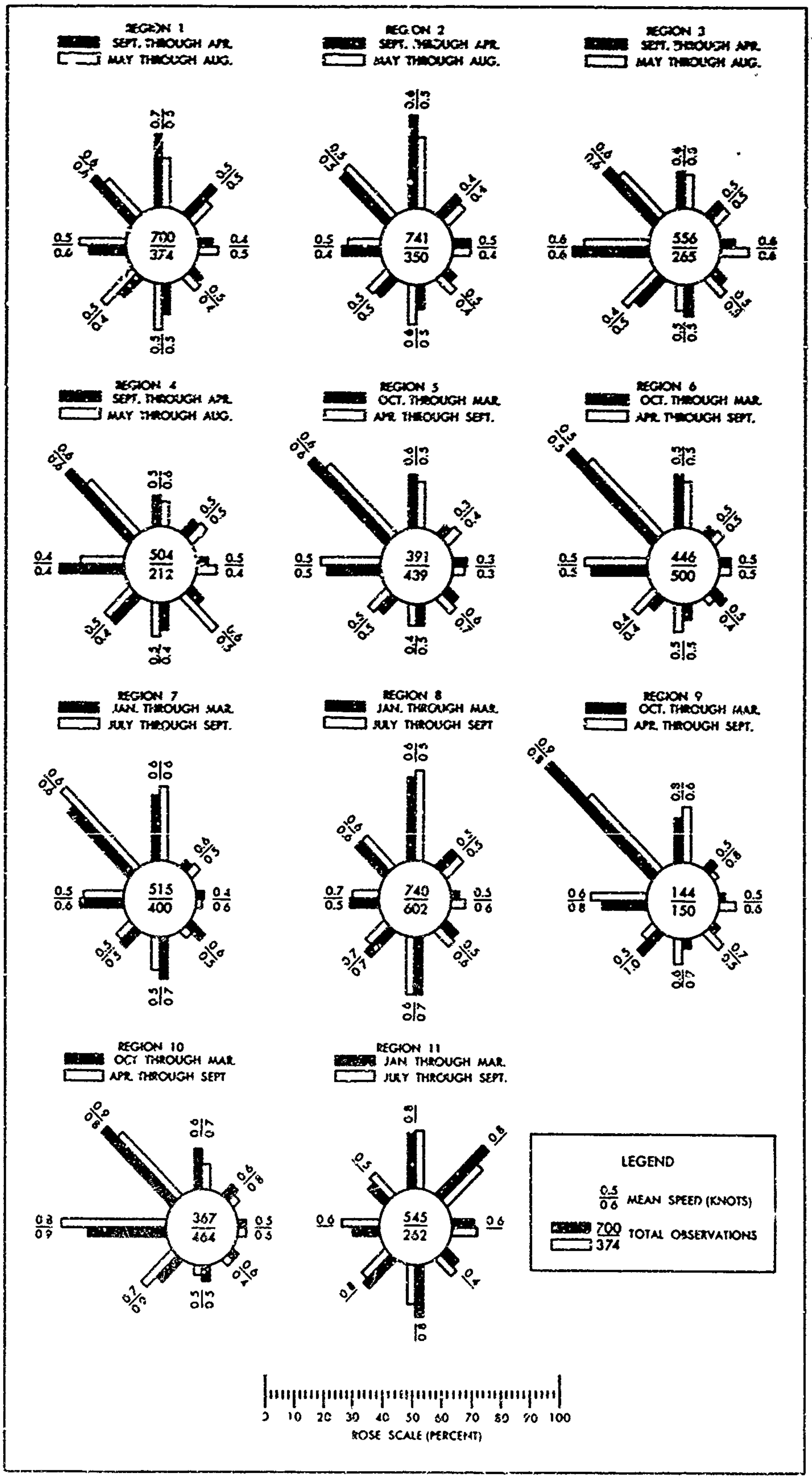

FIGURE 9 SURFACE AND SUBSURFACE FLOW OF PERU CURRENT, CONTINUED

flows pass into the region of the trade winds. The current follows the coast and joins the Pacific South Equatorial Current beyond 100°W.

The surface current shows a high constancy throughout the greater part of its length and is little affected by latitude or season. What seasonal variation does occur is shown in the surface current roses in Figure 9; the current tends to be most variable south of 10°S during the southern winter and north of 10°S during the southern summer. The current most frequently flows at speeds ranging between 0.2 and 1.4 knots, being strongest off the Peru coast; maximum speeds occur at its northern extremity between the continent and the Galapagos Archipelago. The currents are stronger near shore and weaken with increasing distance from shore.

In some regions, however, the current is very weak, with eddies occurring at irregular intervals; south-setting countercurrents frequently flow close to shore as indicated by the south component of the surface current roses. Because of the moderate speed and variability of the Peru Current, its exact west boundary is difficult to determine; the flow west of the Peru Current is also markedly northward, and there is no sudden change between the coastal zone of more persistent flow and the oceanic region of less stable or weaker flow.

Observations have shown that the current close inshore is under the nearly continuous influence of small-scale upwelling (Figure 10). Steady southerly winds along the coast tend to force

the surface water offshore and produce continuous vertical circulation. Upwelling occurs between about 30° and 5°S as shown in Figure 10 and is limited mainly to the upper 200 to 300 meters. South of 15°S, upwelling is less intense.

Results of direct current measurements indicate a southward subsurface flow along the edge of the Continental Shelf at depths below 300 meters between northern Peru and at least as far south as 41°S. Off Peru and northern Chile, speeds to 0.4 knot were recorded; like the surface current, the speed of this undercurrent is weaker in the southern part of the Peru Current, especially south of 15°S. Figure 9 shows results of direct subsurface current measurements at four locations within the Peru Current.

Volume transport of this undercurrent has been computed at about 21 x 10^6 m^3/sec at 5°S, decreasing to about 3 x 10^6 m^3/sec at 15°S. The decrease in volume of southward flow occurs mainly in the region of strongest upwelling and may be due to continual loss through vertical and horizontal transport.

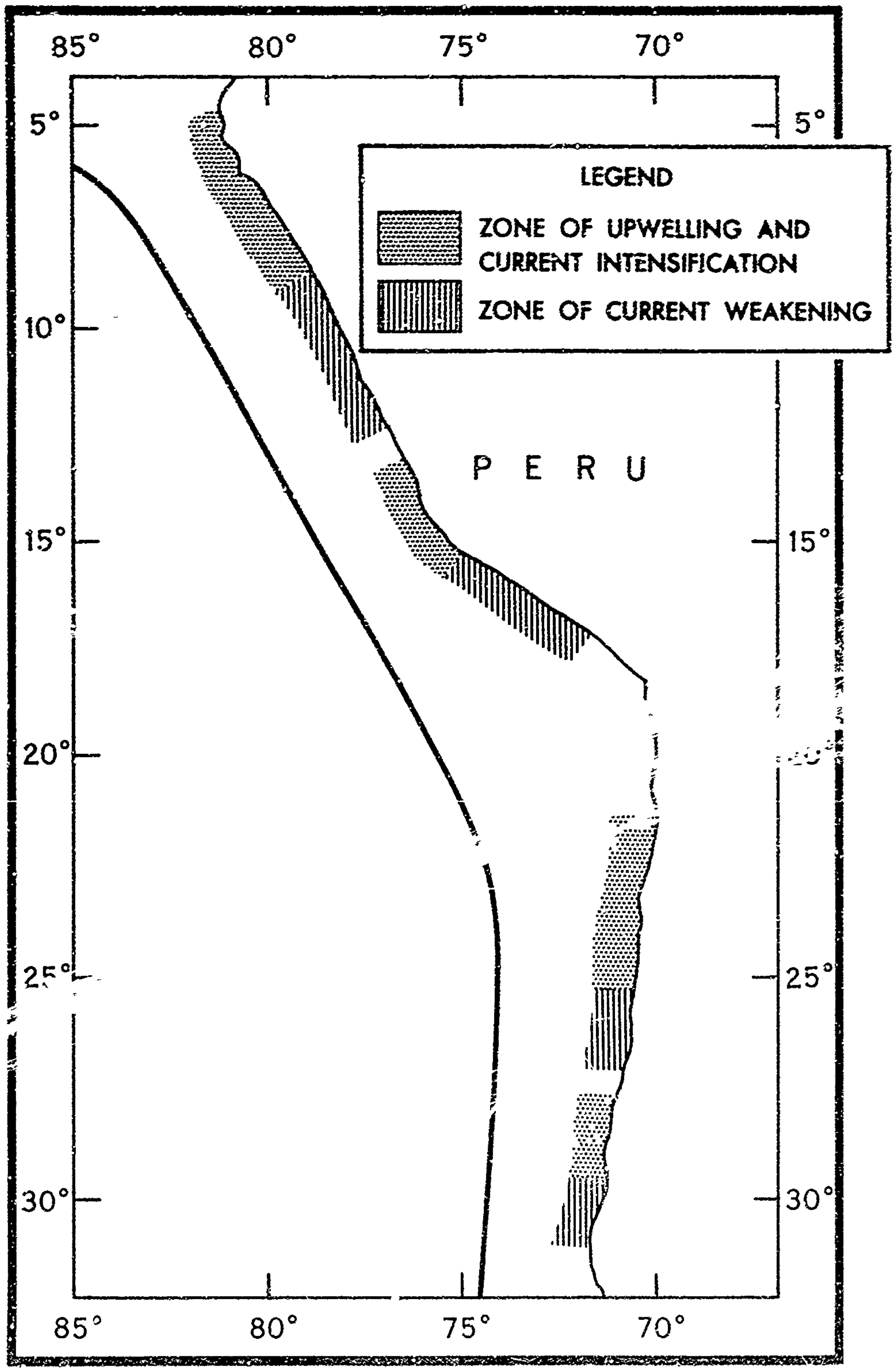

FIGURE 10 UPWELLING AND WEAKENING OF PERU CURRENT

Conclusions

An examination of existing data sources clearly shows that the methods utilized to determine the principal characteristics of ocean currents leave much to be desired. From the many and varied types of information available, it is obvious that detailed, accurate descriptions of currents cannot be readily obtained and that some currents will continue to be better known than others.

It is generally agreed that ocean current information is very sparse and usually insufficient for most ocean areas. Where there are sufficient ship drift observations, satisfactory current patterns can be derived; the number of reliable current meter measurements at sea is negligible. As more and better data become available, the descriptions of the currents in this report can be refined to a greater degree of precision.

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13. ABSTRACT

The descriptions of eight principal currents in this report are based on data obtained by direct methods in regions from the Bering Sea to Cape Horn. Except for the Peru and Cape Horn Currents, surface flows appear to be ill defined and exhibit characteristic variability. The usual graphic presentation of ocean currents is, at best, a static picture. The surface of the ocean is in constant motion, the movement being exceedingly variable in some regions and relatively constant in others. The currents described in this report are those where the movement within specified boundaries exhibits a permanent or seasonal flow.

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North America						
South America						
Alaska Current						
Bering Current						
California Current						
Cape Horn Current						
Davidson Current						
El Nino						
Mentor Current						
Peru Current						

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